INTERVERTEBRAL STAPLE GRADING SYSTEM WITH MICRO-CT

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Introduction:

Intervertebral stapling is a leading method of fusionless scoliosis treatment [1] which attempts to control growth by applying pressure to the convex side of a scoliotic curve in accordance with the Hueter-Volkmann principle [2, 3]. In addition to that, staples have the potential to damage surrounding bone during insertion and subsequent loading. The aim of this study was to assess the extent of bony structural damage including epiphyseal injury as a result of intervertebral stapling using an in vitro bovine model.

Materials and Methods:

Thoracic spines from 6-8 week old calves were dissected and divided into motion segments including levels T4-T11 (n=14). Each segment was potted in polymethylemethacrylate. An Instron Biaxial materials testing machine with a custom made jig was used for testing. The segments were tested in flexion/extension, lateral bending and axial rotation at 37^0C and 100% humidity, using moment control to a maximum 1.75 Nm with a loading rate of 0.3 Nm per second for 10 cycles. The segments were initially tested uninstrumented with data collected from the tenth load cycle. Next an anterolateral 4-prong Shape Memory Alloy (SMA) staple (Medtronic Sofamor Danek, USA) was inserted into each segment. Biomechanical testing was repeated as before. The staples were cut in half with a diamond saw and carefully removed. Micro-CT scans were performed and sagittal, transverse and coronal reformatted images were produced using ImageJ (NIH, USA).The specimens were divided into 3 grades (0, 1 and 2) according to the number of epiphyses damaged by the staple prongs. The cross section of the prongs just proximal to the chamfer was measured for analysis (to exclude the insertion length as a variable). The data were analysed using descriptive statistics, repeated measures ANOVA and paired t-tests.

Results:

There were 9 (65%) segments with grade 1 staple insertions and 5 (35%) segments with grade 2 insertions. There were no grade 0 staples. Grade 2 spines had a higher stiffness level than grade 1 spines, in all axes of movement, by 28% (p=0.004). This was most noted in flexion/extension with an increase of 49% (p=0.042), followed by non-significant change in lateral bending 19% (p=0.129) and axial rotation 8% (p=0.456) stiffness. The cross sectional area of bone destruction from the prongs was only 0.4% larger in the grade 2 group compared to the grade 1 group (p=0.961).

Conclusion:

Intervertebral staples cause epiphyseal damage. There is a difference in stiffness between grade 1 and grade 2 staple insertion segments in flexion/extension only. There is no difference in the cross section of bone destruction as a result of prong insertion and segment motion.

References:

1. Betz, RR, et al., *An innovative technique of vertebral body stapling for the treatment of patients with adolescent idiopathic scoliosis: a feasibility, safety, and utility study.* Spine, 2003. **28**(20): p. S255-65.
2. Hueter, C. *Anatomische Studien an den Extremitätengelenken Neugeborener und Erwachsener.* Archiv für pathologische Anatomie und Physiologie und für klinische Medicin, 1862. **25**(5-6): p. 572-599.
3. Volkmann, R., *Chirurgische Erfahrungen über Knochenverbiegungen und Knochenwachsthum.* Archiv für pathologische Anatomie und Physiologie und für klinische Medicin, 1862. **24**(5-6): p. 512-540.